

Fluid-Sediment Interactions In The Nearshore

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LONG-TERM GOALS

The long range goal of this research is to identify and understand the relevant small scale processes of coastal sediment transport which are necessary for inclusion in numerical models for the evolution of larger scale coastal morphology.

OBJECTIVES

The immediate objectives of this project are to examine the relevant importance of various time and space scales of sediment transport. In particular, we are in the process of determining whether coastal sediment transport can be envisioned as the aggregate of a limited number of separate transport components which are differentiated by their temporal scales. As well as identifying what these components are, we are also examining how these components vary as a function of incident forcing, location within the surf zone and vertical position.

APPROACH

Seven weeks worth of measurements of the vertical profile of sediment concentration and fluid velocity from a 2-D grid which spans the surf-zone have been collected as part of the Sandy Duck experiment which was held during September and October 1997 at the USACOE field research facility at Duck, North Carolina. These measurements were obtained from stacks of fiber-optic back-scatter sensors (FOBS) collocated with vertical arrays of electro-magnetic current meters (VEMA). These measurements will be used to estimate the temporal and spatial distribution of sediment flux over the surf-zone. The frequency distribution of sediment flux will be determined from the cross-spectra of concentration and velocity and the flux will be partitioned into mean, incident and infra-gravity components. This information will be examined to identify the relative importance of these components as a function of surf-zone location and fluid forcing as well as to determine the importance of the divergence of these components on morphologic evolution.

WORK COMPLETED

The field work and data collection portion of the project has been completed and 16 Hz field data has been examined for data quality, decimated to 2 Hz and archived in 8 separate databases representing approximately 5 Gigabytes of data. Pressure, velocity and concentration measurements are available 24 hours/day at 9 locations with 5 in the longshore and 5 in the cross-shore. Routine post-processing

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data analysis tasks have involved the final correction of sensor orientation problems, development of software analysis tools, and the determination of sub-periods of data which are of particular interest. Periods of rapid bathymetric change (over 10 cm. of deposition or erosion occurring throughout the array within $O(10)$ hours) were identified as being of particularly high initial interest and through the use of the analysis tools, 5 such events were identified in the data set. In these events, two different patterns of bottom change are observed to occur, one where bottom movement occurs as a gradual continuous process and a second where net bottom movement is obscured by a series of relatively rapid oscillations of the bottom.

Detailed analysis has been carried out on the data from the 8-11 October 1997, a period which spans one of these events. Bottom locations for all instrument clusters throughout all data runs in this period have been determined and the magnitude of the incident, infragravity, and mean transport was determined for successive 512 s intervals. Individual vertical partition distributions for each run and each cluster have been developed as well as aggregate distributions.

RESULTS

The most significant results of the analysis from this work can be observed in Figure 1. This figure shows vertical profiles of the contributions of the various transport components to the total sediment transport signal (d). There are several significant points which can be observed in this figure. First we see that while there does appear to be a net offshore transport bias (d.), but that, especially near the bed, there are significant onshore contributions. Second, the contribution from the infragravity component (b.) (defined as the contributions with a frequency less than 0.05 Hz) is secondary in nature and seems to have no particular bias. Third, the incident wave component is predominantly onshore and is very highly concentrated near the bed. In the regions very near the bed, this component appears to be even greater than the mean component. Finally, the mean component, which is exclusively offshore, appears to have a thicker structure with significant transport extending higher in the water column. It should be noted that the majority of previous measurements which have examined this issue, occurred in this part of the water column.

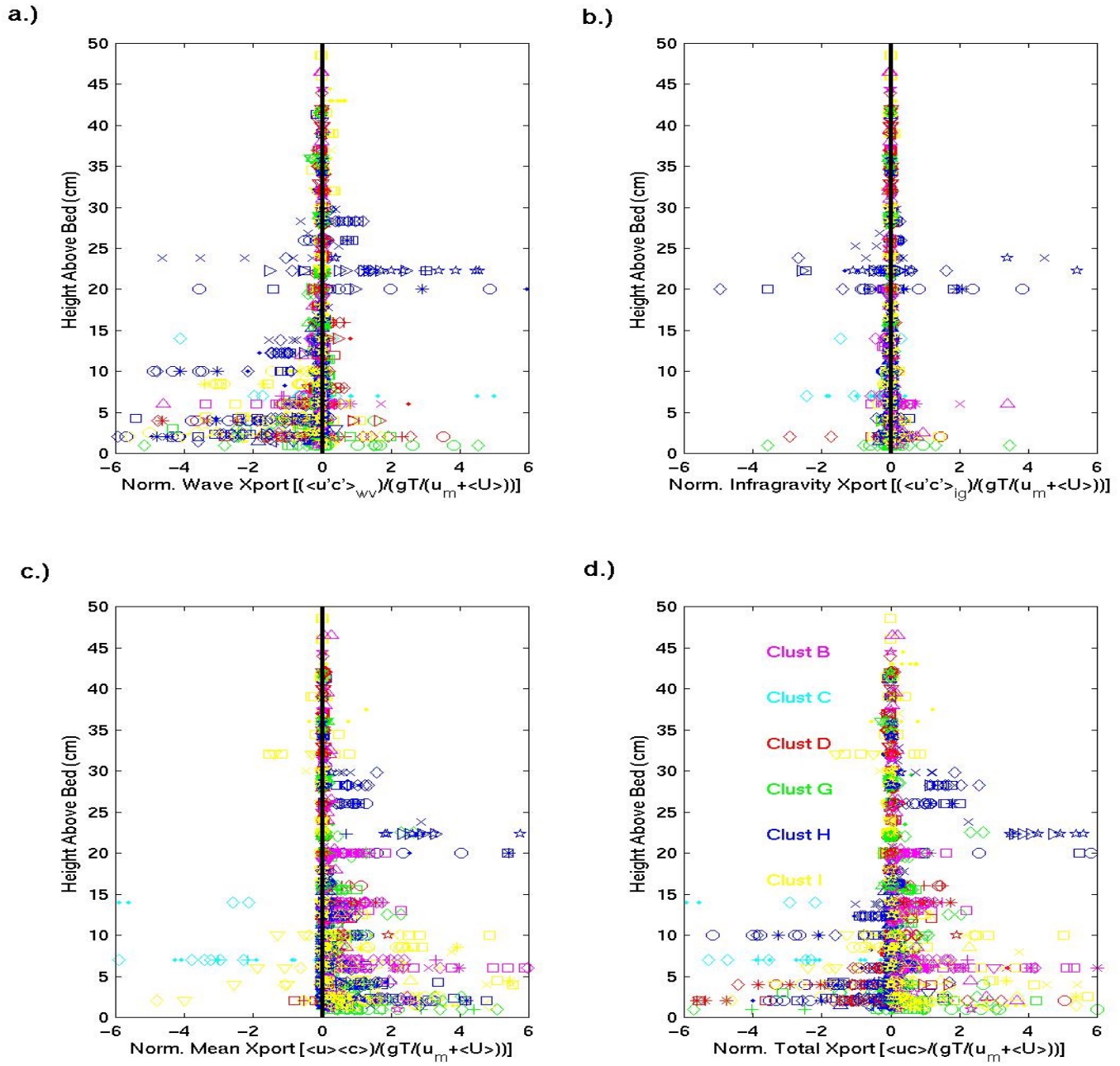


Figure 1: Distributions of sediment transport components for 14 three hour data runs spanning 8-11 October 1997. Each point represents a 512 s interval and only intervals where the bottom location remained constant (within the accuracy of the instrumentation) for the entire interval are plotted. Different colors indicate different instrument clusters. All transport rates are normalized by the factor $\frac{(u_m + \langle U \rangle)}{gT}$, where u_m is the magnitude of the orbital velocity, U is the total velocity vector and T is the peak wave period. This factor is representative of the mean bed stress as well as fluid accelerations during the interval.

IMPACT/APPLICATIONS

Cross-shore transport in the surf zone during storm events has been seen to be predominantly the resultant of two components, the mean and the wave component, with the net transport depending on which of the two components is dominant. This result suggests that sediment transport in such an environment may be successfully modeled as the combination of these two separate transport components.

The dominance of the wave component near the bed and the mean component higher in the water column brings into question inferences of net sediment transport from flux measurements at one vertical location.

TRANSITIONS

The data from this project has been collected and is being used in conjunction with Drs. R. Sternberg and A. Ogston (U. Wash.) and R. Beach (ONR).

RELATED PROJECTS

See above.